boulders and pieces of rock, scratched and scored with the unmistakeable lines that glaciers alone produce. These phenomena he observed to be repeated, or rather continued, throughout the highland, which he crossed three times at intervals, including above 100 miles of its length.

About the midmost of the plateau stands a solitary, dome-like eminence, nearly 8,000 feet above the sea level, and rounded off in every direction. On the west side of this mountain, now known as "Yelish Dagh," near its base, Mr. Palgrave found a second moraine, consisting of a single stone bank five or six hundred yards in length, stretching down to a valley below: its higher extremity was at about 6,500 ft. And lastly, at the great cleft about fifty miles distant, called the Cherdakh Pass, and leading downwards from the plateau into the Euphrates valley, he observed a third moraine, larger than either of the two former, and extending over a slope of fully 2,000 ft., its base being only about 4,500 ft. above the sea.

From these and similar indications, Mr. Palgrave conjectured that during the glacial period an ice-cap of fifty miles in average breadth, and many hundred in length, must have covered this table-land from a height of 6,000 ft.. or rather less, upwards; while some of the more advanced glaciers may have reached to a far lower level, seemingly 4,000 ft.

Such were the most remarkable surface-phenomena of the plateau itself. But on its margin, whether north or south, and connected with it, were other indications of an analogous character. These consisted in the traces afforded by broad and deep ravines and neighbouring river beds, much too wide for the streams that flow through them; all affording evidence of a past epoch when the water supply was on a far more copious scale than it is now. Thus the valley of the Euphrates itself, which takes its rise in this very plateau, is, in its evenly-scooped extent of three and even four miles across, out of all proportion with the comparatively little and feeble stream that now meanders along it; and the same must be said of most of the aqueous modifications imprinted in the lower mountain ranges, and in the plains at their feet.

But of all the phenomena of this kind none is more remarkable than that inspected by Mr. Palgrave near the sea-end of the great valley by which the river, once Pyxartes, now "Deyermend-Dereh," or "Mill Stream" enters the Euxine, close by Trebizond. This river, whose waters are derived from the central table land, is now so shallow as to be readily fordable at almost every season of the year, and brings down with it just enough pebble and soil to form a little bar at its mouth. Half a mile, however, from the present beach the river valley, here about a third of a mile in width, is in its greater part crossed by a huge bar of rolled stones, at least forty feet in eight, and eighty or a hundred yards in thickness at its base, evidently formed here by the joint action of river and sea. The stones, many of which are of great size, belong to Jurassic or Plutonic formations, such as compose the plateau inland, whereas the coast-rock is entirely volcanic. But the flood of water requisite to bring them from such a distance is now wholly wanting. Nor can its diminution be ascribed to the extirpation of forest wood, for the mountain chain is still as densely clothed with trees as it could ever have been in remote times; nor yet to an alteration in the course and dip of the valleys that unite to send their supplies hither, for there is no trace of any great geological change hereabouts within the epoch to which the bar itself is referable. One only cause there could have been capable of furnishing so impetuous a stream, namely, the periodical melting of great masses of ice and snow on the mountains behind, now unusually bare of snow from June till November, and absolutely denuded of anything approaching to a glacier. When these icy reservoirs ceased the abundance of the river ceased also, leaving the bar alone as a monument of its former strength.

T. P.

THE INHABITANTS OF THE MAMMOTH CAVE OF KENTUCKY

CRUSTACEANS AND INSECTS

THE following account of the inhabitants of the Mammoth Cave of Kentucky is abridged from the *American Naturalist.* To the courtesy of the editors of that journal we are further indebted for the accompanying illustrations:—

After the adjournment of the meeting of the American Association for the Advancement of Science, held at Indianapolis in August last, a large number of the members availed themselves of the generous invitation of the Louisville and Nashville Railroad Company, to visit this world-renowned cave, and examine its peculiar formation and singular fauna.

The cave is in a hill of the subcarboniferous limestone formation in Edmondson County, a little to the west and south of the centre of Kentucky. Green river, which rises to the eastward in about the centre of the State, flows westward, passing in close proximity to the cave, and receiving its waters, thence flows north-westerly to the Ohio. The limestone formation in which the cave exists is a most interesting and important geological formation, corresponding to the mountain limestone of the European geologists, and of considerable geological importance in the determination of the western coalfields.

We quote the following account of this formation from Major S. S. Lyon's report in the fourth volume of the "Kentucky Geological Survey," pp. 509, 510:—

"The sinks and basins at the head of Sinking Creek exhibit in a striking manner the eroding effects of rains and frost—some of the sinks, which are from 40 ft. to 190 ft. deep, covering an area of from 5 to 2,000 acres. The rim of sandstone surrounding these depressions is, generally, nearly level; the out-cropping rocks within are also nearly horizontal. Near the centre there is an opening of from 3 ft. to 15 ft. in diameter; into this opening the water which has fallen within the margin of the basin has been drained since the day when the rocks exposed within were raised above the drainage of the country, and thus, by the slow process of washing and weathering, the rocks which once filled these cavities have been worn and carried down into the subterranean drainage of the country. All this has evidently come to pass in the most quiet and regular manner. The size of the central opening is too small to admit extraordinary floods; nor is it possible, with the level margin around, to suppose that these cavities were worn by eddies in a current that swept the whole cavernous member of the subcarboniferous limestone of western Kentucky; but the opinion is probable that the upheaving force which raised these beds to their present level at the same time ruptured and cracked the beds in certain lines: that afterwards the rains were swallowed into openings on these fractures, producing, by denudation, the basins of the sinkhole country, and further enlarging the original fractures by flowing through them, and thus forming a vast system of caverns, which surrounds the western coalfield. The Mammoth Cave is at present the best known, and therefore the most remarkable."

So much has been written on the cave and its wonders, that to give a description of its interior would be superfluous in this connection, even could we do so without unintentionally giving too exaggerated statements, which seems to be the natural result of a day underground, at least so far as this cave is concerned, for, after reading any account of the cave, one is disappointed at finding the reality so unlike the picture.

We are indebted to Prof. Alexander Winchell, of the University of Michigan, for the following abstract of his views concerning the formation of the cave:—

"The country of the Mammoth Cave was probably dry land at the close of the coal period, and has remained

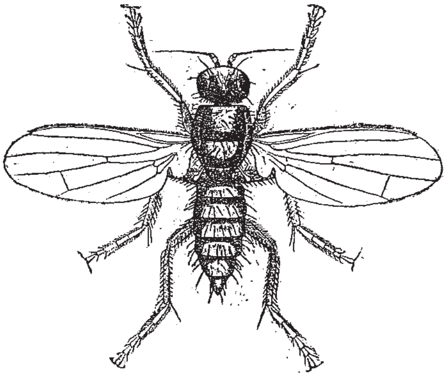

Fig. 1.—Anthomyia.

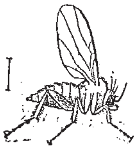

Fig. 2.—Phora.

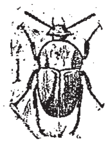

Fig. 4. Adelops hirtus.

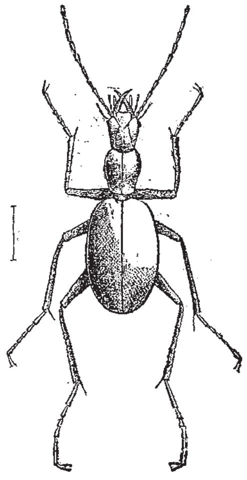

Fig. 3.—Anophthalmus Tellkampfii.

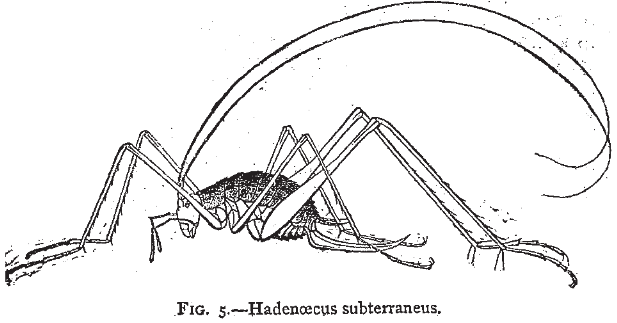

Fig. 5.—Hadenœcus subterraneus.

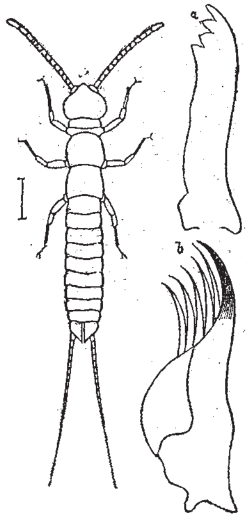

Fig. 6.—Campodea.

such, with certain exceptions, through the Mesozoic and Cænozoic ages, and to the present. In Mesozoic times, fissures existed in the formation, and surface waters found their way through them, dissolving the limestone and continually enlarging the spaces. A cave of considerable dimensions probably existed during the prevalence of the continental glaciers over the northern hemisphere. On the dissolution of the glaciers, the flood of water which swept over the entire country, transporting the materials which constituted the modified drift, swept through the passages of the cave, enlarging them, and leaving deposited in the cave some of the same quartzose pebbles which characterise the surface deposits from Lake Superior to the Gulf of Mexico. Since the subsidence of the waters of the Champlain epoch, the cave has probably undergone comparatively few changes. The well, 198 ft. deep, at the farther end of the cave, shows where a considerable volume of the excavatory waters found exit. The Mammoth Dome indicates probably both a place of exit and a place of entrance from above. So of the vertical passages in various other portions of the cave.”

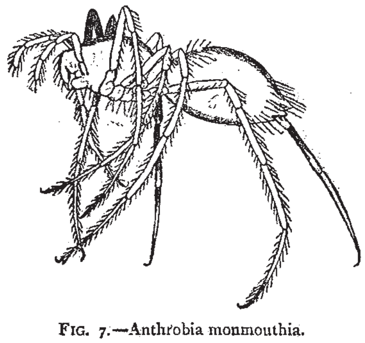

Fig. 7.—Anthrobia monmouthia.

We believe that the views of Prof. Winchell are in harmony with those of the other eminent geologists of the party; and when it is considered that the geologists of this excursion stand in the front rank of the most eminent scientific men of the world, their views upon this interesting subject are well worthy of attention.

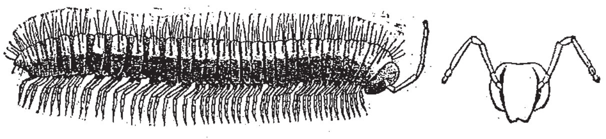

Fig. 9.—Spirostrephon Copei.

With these general remarks on the cave, we give a brief account of its interesting fauna, comprising representatives of the insects and crustaceans. No molluscs or radiates have as yet been discovered; but the lower forms of life have been detected by Tellkampf, who collected several species belonging to the genera *Monas*, *Chilomonas*, and (?) *Chilodon*.

Representatives of all the grand divisions of the insects and crustaceans have been found in this cave, and if no worms have yet been detected one or more species would undoubtedly reward a thorough search.

We will enumerate what have been found, beginning with the higher forms. No Hymenoptera (bees, wasps, and ants) or Lepidoptera (moths) are yet recorded as being peculiar to caves. The Diptera (flies) are represented by two species, one of Anthomyia (Fig. 1), or a closely allied genus, and the second belonging to the singular and interesting genus Phora (Fig. 2.) The species of Anthomyia usually frequent flowers; the larvæ live in decaying vegetable matter, or, like the onion fly, attack healthy roots. It would be presumptuous in the writer to attempt to describe these forms without collections of species from the neighbourhood of the cave, for though like all the rest of the insects they were found three or four miles from the mouth, yet they may be found to occur outside of its limits, as the eyes and the colours of the body are as bright as in other species.

Among the beetles, two species were found by Mr. Cooke. The *Anopthalmus Tellkampfii* of Erichson, a Carabid (Fig. 3), and *Adelops hirtus* Tellkampf (Fig. 4), allied to Catops, one of the Silphidæ or burying beetle family. The Anopthalmus is of a pale reddish horn colour, and is totally blind ;[*] in the Adelops, which is greyish brown, there are two pale spots, which may be rudimentary eyes, as Tellkampf and Erichson suggest. No Hemiptera (bugs) have yet been found either in the caves of this country or Europe. Two wingless grasshoppers (sometimes called crickets) like the common species found under stones (*Ceuthophilus maculata* Harris), have been found in our caves; one is the *Hadenœcus subterraneus* (Fig. 5 nat. size) described by Mr. Scudder, and very abundant in Mammoth Cave. The other species is *H. stygia* Scudder, from Hickman's cave, near Hickman's landing, upon the Kentucky river. It is closely allied to the Mammoth Cave species. According to Mr. Scudder the specimens of *H. stygia* were found by Mr. A. Hyatt "in the remotest corner of Hickman's Cave, in a sort of a hollow in the rock, not particularly moist, but having only a sort of cave dampness. They were found a few hundred feet from the sunlight, living exclusively upon the walls." Even the remotest part of that cave is not so gloomy but that some sunlight penetrates it.

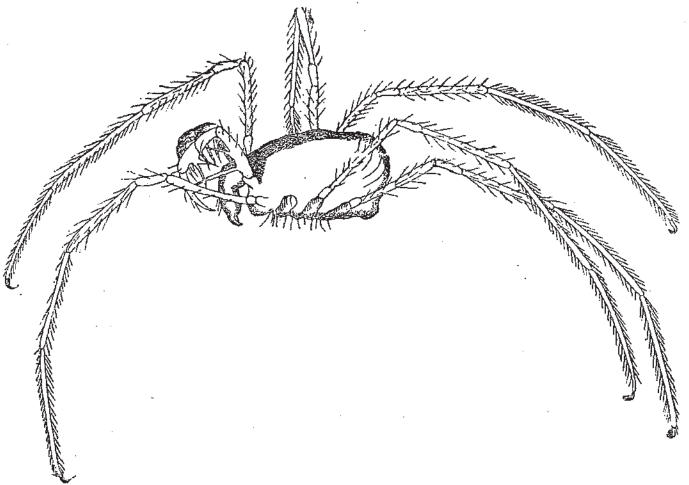

FIG. 8 — Acanthocheir armata.

The other species is found both in Mammoth Cave, and in the adjoining White's Cave. It is found throughout the cave, and most commonly (to quote Mr. Scudder) "about 'Martha's Vineyard" and in the neighbourhood of 'Richardson's Spring' where they were discovered jumping about with the greatest alacrity upon the walls, where only they are found, and even when disturbed, clinging to the ceiling, upon which they walked easily; they would leap away from approaching footsteps, but stop at a cessation of the noise, turning about and swaying their long antennæ in a most ludicrous manner, in the direction whence the disturbance had proceeded; the least noise would increase their tremulousness, while they were unconcerned at distant motions, unaccompanied by sound, even though producing a sensible current of air; neither did the light of the lamp appear to disturb them; their eyes, and those of the succeeding species (*H. stygia*), are perfectly formed throughout, and they could apparently see with ease, for they jump away from the slowly approaching hand, so as to necessitate rapidity of motion in seizing them."

The Thysanurous Neuroptera are represented by a species of Machilis, allied to our common *Machilis variabilis* Say, common in Kentucky and the middle and southern States. So far as Tellkampf's figure indicates, it is the same species apparently, as I have received numerous specimens of this widely distributed form from Knoxville, Tennessee, collected by Dr. Josiah Curtis. It was regarded as a crustacean by Tellkampf, and described under the name of *Triura cavernicola*.[†] He mistook the labial and maxillary palpi for feet, and regarded the nine pairs of abdominal spines as feet. The allied species, *M. variabilis* Say, is figured in vol. v. pl. 1, figs. 8, 9.

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[*] In Erhardt's cave, Montgomery Co., Virginia, Prof. Cope found "four or five specimens of a new Anopthalmus, the *A. pusio* of Horn, at a distance of not more than three hundred feet from its mouth. The species is small, and all were found together under a stone. Their movements were slow, in considerable contrast to the activity of ordinary Carabidæ." Proc. Amer. Phil. Soc. 1869, p. 178.

[†] Prof. Agassiz, in his brief notice of the Mammoth Cave animals, does not criticise Tellkampf's reference of this animal to the crustacea; and so eminent an authority upon the articulates as Schiödte remarks, while "Dr. Tellkampf's account affords us no means of forming any conclusion as to its proximate relations," that, however, it "appears to belong to the order of Amphipoda, and to have a most remarkable structure" Tellkampf's figure of Machilis is entirely wrong in representing the labial and maxillary palpi as ending in claws, thus giving the creature a crustacean aspect, and, indeed, he describes them as true feet!

An interesting species of Campodea, of which the accompanying cut (Fig. 6) is a tolerable likeness, though designed to illustrate another species (*S. staphylinus* Westw.) was discovered by Mr. Cooke. Both the European and our common species live under stones in damp places, and the occurrence of this form in the water is quite remarkable. The other species are blind, and I could detect no eyes in the Mammoth Cave specimen.

A small spider was captured by Mr. Cooke, but afterwards lost; it was brown in colour, and possibly distinct from the *Anthrobia monmouthia* Tellkf. (Fig. 7), which is an eyeless form, white and very small, being but half a line in length. The family of Harvest men is represented by a small white form, described by Tellkampf under the name of *Phalongodes armata* (Fig. 8), but now called *Acanthocheir armata* Lucas. The body alone is but half a line long, the legs measuring two lines. It should be borne in mind that many of the spiders, as well as the Thysanura, live in holes and dark places, so that we could naturally find them in caves. So, also, with the Myriopods, of which a most remarkable form (Fig. 9 front of head) was found by Mr. Cooke three or four miles from the mouth of the cave. It is the only truly hairy species known, an approach to it being found in *Pseudotremia Vudii* Cope. It is blind, the other species of this group which Prof. Cope found living in caves having eyes. The long hairs arranged along the back seem to suggest that they are tactile organs, and of more use to the thousand legs in making its way about the nooks and crannies of a perpetually dark cave than eyes would be. It was found by Mr. Cooke under a stone.

Prof. Cope has contributed to the "Proceedings of the American Philosophical Society" (1869, p. 171) an interesting account of the cave mammals, articulates, and shells of the middle states. He says that "myriopods are the only articulates which can be readily found in the remote regions of the caves (of West Virginia) and they are not very common in a living state." The *Pseudotremia cavernarum* which he describes, "inhabits the deepest recesses of the numerous caves which abound in Southern Virginia, as far as human steps can penetrate. I have not seen it near their mouths, though its eyes are not undeveloped, nor smaller than those of many living in the forest. Judging from its remains, which one finds under stones, it is an abundant species, though rarely seen by the dim light of a candle even after considerable search. Five specimens only were procured from about a dozen caves." The second species, *P. Vudii* Cope, was found in Montgomery Co., and he thinks it was not found in a cave. Prof. Hyatt informs me that he saw near the "Bottomless Pit" in Mammoth Cave, a brownish centipede-like myriopod, over an inch in length, which moved off in a rapid zigzag motion. Unfortunately, he did not capture it.

A. S. PACKARD, JUN.

(*To be continued*)

NOTES

WE have received information of a most munificent act on the part of that veteran in Geological Science, Sir William E. Logan, in supplementing, by the handsome gift of 18,000dols., the sum of 2,000 dols. given by him and his brother, Mr. Hart Logan, last year towards the endowment of the Chair of Geology in M'Gill University, Montreal. The "Logan Chair of Geology" will be at once a commemoration of Sir William's name in connection with the higher education of our colonists, and a means of perpetuating the teaching of the Science for which he has done so much, as well as of securing the training of a succession of young men who may worthily follow up his investigations in the wide field of Canadian Geology. Principal Dawson, who at present occupies the Chair of Geology, will be the first "Logan Professor," and it is intended that the endowment shall, as soon as possible, be made the means of relieving him from the teaching of some other portions of natural science, in order that he may more fully devote his time to Geology and Palæontology.

PROF. HUXLEY is now on his way home to England, having been last heard of from Naples. His health is very greatly restored by his absence from work, and the effects of the Egyptian climate.

DR. M'NAB, Professor of Botany and Geology at the Royal Agricultural College, Cirencester, has been appointed Professor of Botany to the Royal College of Science and Art, Dublin, in the place of Prof. Thiselton Dyer. The appointment is a good one, on which we congratulate the Science and Art Department. The lectureship at the Cirencester College is now vacant.

THE death of the Swiss palæontologist, M. Pictet de la Rive, Professor in the Academy of Geneva, which we noticed last week, took place on the 15th ult. at the age of sixty-two, and was occasioned by fever induced by a severe accident.

DR. GEORGE BURROWS, F.R.S., has been re-elected President of the College of Physicians.

PROF. HUXLEY was defeated by a small majority by Lord Neaves in the election for the Rectorship of St. Andrew's University. Prof. Sylvester was also, we regret to say, unsuccessful in his candidature for the School Board for Marylebone. We understand, however, that there will shortly be another vacancy on the Board, when we trust Science will once more put in its claim.

THE Brighton Aquarium was formally opened to the public on Saturday last.

IT has been decided to give a private view and evening reception in the Picture Galleries of the London International Exhibition of 1872 before the 1st of May, to which distinguished foreigners and holders of season tickets will be invited.

AT Rugby Mr. Wilson and Mr. Seabroke have tried the experiment of giving regular lectures on Astronomy to a class consisting of volunteers from the school and residents in the town. Note-books were shown up and corrected, and an examination held at the end. About seventy attended, twenty being members of the school; thirty showed up note-books, and eighteen presented themselves for examination. Advocates of women's education will be pleased to learn that the two best note-books were written by girls, and that in the examination, which was a stiff one (we have seen the paper), girls held the second, third, and fifth places. The proceeds are for buying books for the Temple Observatory.

AN organisation, entitled the Bloomington Scientific Association, was instituted at Bloomington, Illinois, in 1871, having for its object the diffusion and popularising of science in that State. The officers are Prof. B. S. Perry, Mr. R. H. Holder, Dr. Vasey, and Mr. J. A. Jackman. The society has already a large number of members, and meets frequently.

THE great depression of temperature during November and the early part of December, was followed by an extraordinarily long period of more than three months' remarkably mild weather. For the ninety-seven days from December 13 to March 18, Mr. Glaisher's Greenwich tables, recorded weekly in the *Gardener's Chronicle*, show that the temperature was above the average on eighty-nine, and below the average on only eight days, the mean excess for the whole period being 5°·1. During the whole of this period the thermometer fell below the freezing point on four nights only, viz., January 15 and 16, and March 10 and 11; the lowest temperature recorded being 28°·3 Fahr. on the first and last of these dates.